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## MEDICAL ZOOLOGY AND HUMAN WELFARE[1]

EVERY one is more or less familiar with the relation of medical zoology to human welfare, but many of us do not realize what a very great influence both the scientific and practical phases of this subject have had upon our daily lives and upon the progress of the human race. Medical zoology is the subdivision of the great science of zoology which deals with groups of animals selected on the basis of their intimate association with man. Certain of these animals, such as scorpions and snakes, are of medical importance because of their venomous bites; others, such as certain game animals of Africa that harbor the germs of sleeping sickness, act as reservoirs from which transmitting agents obtain their infections; and some animals carry as external parasites the transmitting agents themselves, such as the rat which is infested with plague fleas. Zoologically the principal group with which medical zoologists are concerned are the parasitic protozoa, parasitic worms and the insects that may transfer these organisms as well as bacteria and filterable viruses from an infected to an uninfected animal. Since most of these organisms are parasites the terms medical zoology and parasitology are often used synonymously.

Medical zoologists do not limit themselves to the study of those parasites or insects that have been proved to be directly concerned in human diseases but investigate also the parasites of lower animals and plants, since these are usually more easily obtained for experimental work and often belong to the same genera as do the human parasites; hence the results of their study can be translated more or less directly into terms of human parasitism. It may be worth while at this point to define a parasite and separate parasites into their several categories. A parasitic animal is one that lives on or in and at the expense of another animal or plant; the latter is called the host. In many cases animals or plants are closely associated together, one partner benefiting by the association, whereas the other is neither injured nor benefited. This condition is known as commensalism. Again, two closely associated organisms may be mutually beneficial and sometimes one is unable to live without the other. This type of partnership is known as symbiosis. In a third cate-

[1] A lecture delivered at Mt. Holyoke College on November 14, and at Mount Union College on November 19, 1924.

gory belong the true parasites which always injure their host. Some of these are ectoparasites; they live on the outside of the body, and are, to a certain extent, independent of their hosts; among these are insects such as bedbugs, lice and fleas. Others, called entoparasites, succeed in entering the body, where they usually become located in a particular organ or tissue; for example, the dysentery amoeba lives in the intestine, the malarial parasites in the red blood corpuscles and the trichina worms in muscle. The lives of many of these parasites are not particularly happy, since their life-histories are often extremely complex and the conditions that they must contend with in order to maintain themselves and continue their race are such as to make our own mode of existence seem ridiculously simple. Allow me to give several examples.

The commonest liver fluke of man is *Clonorchis sinensis,* a species that occurs in the bile ducts in inhabitants of Japan, China, Korea, Formosa and Cochin China. The true host of this species is man or some flesh-eating animal such as the cat or dog; but before any of these final hosts can be infected the young must pass through two types of intermediate hosts. The eggs of the fluke are laid in the bile ducts of the liver down which they pass into the intestine and thence to the outside. If these eggs chance to find their way into a body of water they soon hatch into free-swimming ciliated larvae called miracidia. No further development takes place unless the miracidia are fortunate enough to encounter a snail of a certain species. When this occurs they energetically burrow their way into the tender body of the snail and grow rapidly at the expense of its soft tissues. Then a period of reproduction ensues, resulting in enormous families of young flukes called cercariae. These cercariae, however, are not yet fashioned in the image of their parents, but must first escape from their birthplace and find certain species of fish in which to spend their adolescent period. After their strenuous efforts to find one of these fish and after burrowing into its tissues they settle down to rest a while and hence form cysts. This resting period may last for a long time, but if infected fish, that is insufficiently cooked, is eaten by man the larval flukes break out of the cysts and many of them migrate into the bile ducts. Here in the bile ducts the larval flukes grow rapidly into vigorous adults and within a month are busily engaged in laying eggs so that the race may not die out. It required the labor of many scientists working over a period of many years to determine all these details, and it must have been very exciting to unravel the tangled threads of this life-cycle, since no one could possibly imagine such a wonderful series of events as these lowly worms live through before they are ready for parenthood. How many of the eggs that are laid reach water; how many of the miracidia that hatch from these eggs succeed in finding the right kind of snail; how many of the cercariae reach the appropriate fish in which to encyst; and how many of these fish are eaten raw by human beings no one knows; but it must certainly be a very small percentage of the original number. Fortunately for the parasite extraordinary powers of reproduction seem to have evolved with the parasitic habit, and enormous numbers of eggs are laid and cercariae developed. At any rate the persistence of the race proves that enough eggs are laid to prevent this lowly worm from becoming extinct amid the complexities of modern life. Well might the successful parent be proud to have overcome the many vicissitudes that beset her path at every turn, and I am sure you will agree with me that our lives seem humdrum indeed compared with that of *Clonorchis sinensis.*

The life-cycle of the malarial organism is equally wonderful, although not complicated by the intervention of *two* intermediate hosts. The malarial sporozoite that is inoculated into the blood of man by the bite of an infected mosquito must successfully avoid the white corpuscles that are always at hand to devour it, and must find a red blood corpuscle into which it can bore its way. Here it is sheltered during its growth period. Finally, however, it divides into a dozen or more daughter merozoites which break out of the blood corpuscle and must in their turn escape the white corpuscles and penetrate fresh red corpuscles. Some of those that succeed develop into sexual forms known as gametocytes. The gametocytes, however, can not continue their development in the blood of man, but perish unless they are sucked up into the stomach of certain species of mosquitoes. If they are so unfortunate as to be engorged by a culex mosquito they are promptly digested, but if the right sort of anopheline mosquito swallows them they are stimulated to further activity; eggs and spermatozoa are formed; fertilization takes place; and a worm-like creature evolves that penetrates the wall of the mosquito's stomach, where a cyst is formed. In this cyst enormous numbers of new sporozoites are produced. These in time break out into the body cavity of the mosquito, and some of them succeed in getting into its salivary glands. Here they finally perish unless their particular mosquito bites a susceptible person and they are fortunate enough to pass out into the blood stream of the new host. Any particular malarial organism obviously has small chance of fulfilling his mission in this world, but so great are the powers of reproduction of these parasites that only one in millions needs to complete

its life-cycle in order to maintain the race successfully.

The facts about *Clonorchis sinensis* and the malarial organism are well known and are accepted by most of us without realizing what a tremendous amount of labor and devotion were required to bring them to light. The history of our knowledge of malaria is of great interest not only *per se* but also as an example of how great discoveries are often brought about by the researches of hosts of first-class investigators covering a period of many years. The disease we know as malaria was recognized long before the causative agent was determined and many opinions were expressed regarding its etiology. It was by various early authorities thought to be due to meteorological conditions or to the effects of changes of temperature on the nervous system or to contaminated drinking water or to be communicated by personal contact, but it was by most people considered to be due to bad air, and many people believe even to-day that damp air is responsible for the disease. These suggestions seem rather ludicrous in the present state of our knowledge of malaria but were seriously discussed at the time they were proposed. Later, various microscopic organisms were announced as the causative agents, including unicellular algae, fungi and bacteria. In the meantime knowledge of animal parasites was increasing; flagellate protozoa (trypanosomes) were discovered in the blood serum of fishes by Valentin in 1841 and sporozoa (haemogregarines) were noted *inside* of blood corpuscles by Bütschli in 1876. So many organisms had been accused of causing malaria that when the true parasite was discovered by Laveran in 1880 its importance was not at first recognized. At this time the attention of scientists was directed toward the so-called Bacillus malariae which Klebs and Tommasi-Crudeli in 1879 claimed to have determined by experimental tests to be the causative organism, and it was not until 1885 that Laveran's findings were generally accepted. The true parasites of malaria were then found in various countries and it was not long before three species were recognized, each responsible for one type of malaria; *Plasmodium vivax* for tertian malaria, *Plasmodium falciparum* for aestivo-autumnal malaria, and *Plasmodium malariae* for quartan malaria. Life-history studies were carried on in many laboratories, but one stage escaped detection for many years and that was the most important part of the life-history, namely, the stage during which the organism is transferred from one human being to another. It was realized, however, that the missing link could easily be supplied if the method of transmission were known; hence for almost two decades some of the best scientific minds of the world were engaged in attempts to find the key to this puzzle. The fascinating story of the discovery of the method of transmission of malaria has recently been published in detail by Sir Ronald Ross in his "Memoirs" and may be cited as an excellent illustration of what can be done by scientific zeal and perseverance under extremely adverse circumstances. The story is too long to be told here, so all I can do is to state that Ross demonstrated in mosquitoes the missing stages in the life-cycle of bird malaria in 1896 and that subsequently Italian investigators proved that anopheline mosquitoes act as the transmitting agents of human malaria.

These discoveries completed our general knowledge of the life-cycle of the malaria parasites and showed us immediately the point where our attack should be directed in order to control malaria since the causative organism can not be transmitted without the presence of certain species of anopheline mosquitoes. Malaria can be prevented from spreading in any locality (1) by destroying all anopheline mosquitoes, (2) by screening infected persons so that mosquitoes when present can not bite them, (3) by screening uninfected persons so that infected mosquitoes do not have access to them and (4) by treating infected persons with quinine so that they can not transmit the organisms to mosquitoes. All these means have been employed with success in various parts of the world. The methods of controlling malaria are now well known, but each locality presents problems of its own that must be overcome before success is assured. The plan that seems to have gained the greatest confidence among public health men is to make a thorough preliminary study of each type of area it is desired to bring under control and then institute measures on a large scale.

The history of yellow fever is similar in many respects to that of malaria. During the past century yellow fever was one of the most dreaded epidemic diseases in the United States, and it is estimated that more than 500,000 cases occurred in this country from 1793 to 1900. Notable outbreaks took place in Boston in 1691 and 1693, in New York in 1668 and up to 1856, in Philadelphia in 1793 and in Baltimore in 1819. One tenth of the population died in the Philadelphia epidemic of 1793. The effect this had on the inhabitants is described by Mathew Cary as follows:

> The consternation of the people of Philadelphia at this period was carried beyond all bounds. Dismay and affright were visible in the countenance of almost every person. Of those who remained, many shut themselves in their houses and were afraid to walk the streets. . . . The corpses of the most respectable citizens, even those who did not die of the epidemic, were carried to the grave on the shafts of a chair (chaise), the horse

driven by a negro, unattended by friends or relative, and without any sort of ceremony. People hastily shifted their course at the sight of a hearse coming toward them. Many never walked on the footpath, but went into the middle of the streets to avoid being infected by passing by houses wherein people had died. Acquaintances and friends avoided each other in the streets and only signified their regard by a cold nod. The old custom of shaking hands fell into such disuse that many shrunk back with affright at even the offer of the hand. A person with a crepe, or any appearance of mourning was shunned like a viper. And many valued themselves highly on the skill and address with which they got to the windward of every person they met. Indeed, it is not probable that London, at the last stage of the plague, exhibited stronger marks of terror than were to be seen in Philadelphia from the 24th or 25th of August until pretty late in September.

New Orleans was periodically visited by yellow fever; in 1853 there were 7,848 deaths, in 1858, 4,854 deaths and in 1878, 4,046 deaths. The last large outbreak in that city appeared in 1905.

Before the causative agent of yellow fever was discovered by Noguchi in 1919 and its transmitting agent was demonstrated by Reed and his coworkers in 1900, it had been attributed to swamps, tropical temperature, atmospheric conditions, etc. The disease was brought under control because of the discovery of the transmitting agent long before its cause was ascertained. Drs. Reed, Carroll, Agramonte and Lazear were sent to Cuba to study yellow fever in 1900. Already in 1881 Dr. Carlos J. Finley had expressed the theory that yellow fever is propagated by mosquitoes, Dr. Henry R. Carter had made careful observations on the incubation period of the disease, and Ross had proved malaria to be transmitted by these insects. Hence the American investigators were able in a very short time to produce yellow fever experimentally in human volunteers by the bites of mosquitoes and thus to lay the foundation for the epoch-making campaigns carried on by General Gorgas and his colleagues in Havana and the Panama Canal Zone. These two campaigns were among the earliest and best for the control of yellow fever and malaria and illustrate two types of control work, that in Havana in a thickly populated municipality and that in Panama in a thinly populated rural district.

Efforts to eradicate yellow fever from Havana by mosquito reduction were begun in 1901 under the direction of General Gorgas at the same time as were similar efforts for the control of malaria. The average death-rate from yellow fever in Havana during the years 1853 to 1900 was 754. In 1901 the destruction of the mosquito vectors brought this number down to 18 and within a few years the entire island of Cuba was declared free from yellow fever.

Malaria control work was started in Havana in 1901. During the preceding decade (1890–1900) there was an average annual death-rate from malaria of 564 among a population of about 350,000, whereas during the next decade (1900–1910) after mosquito control measures had been inaugurated the average annual death-rate was 44, with a largely increased population. Since then malaria has been practically absent from Havana, a condition that is maintained easily and at low cost.

After his successful campaign in Cuba in 1904 General Gorgas began work as chief sanitary officer of the Panama Canal Zone. Here he found a large area covered with jungles, rivers and swamps, presenting new problems for mosquito control. These, as every one knows, were successfully solved and the canal was built. Wet areas in which mosquitoes were breeding were filled, drained or oiled; poisons were added to ponds and streams to kill mosquito larvae; the natural enemies of the mosquitoes, such as fish and dragon flies, were distributed to bodies of water where mosquitoes were breeding; and houses were screened to protect the employes from the adult mosquitoes. The results were quite gratifying. Malaria and yellow fever prevented the French from building the Panama Canal. Their losses have been estimated at fifty thousand men. Within a few years the sanitary officers of the United States had rendered these diseases a negligible factor in the Canal Zone and now one is as safe from malaria and yellow fever in the Panama Canal Zone as he is in New York City.

It is impossible in the time at my disposal to discuss even briefly all the diseases that the study of medical zoology has succeeded in practically eliminating from the world. It is only possible to cite certain interesting examples.

The Katayama disease of Japan, a disease which is known by scientists as schistosomiasis japonica, has only a local distribution in Japan; its most important endemic center being in the Katayama district near Okayama. This area contains about one hundred square miles of territory and at the height of the disease perhaps thirty thousand of its inhabitants were infected. The history of the discovery of the causative agent and its control indicates how remarkably simple the eradication of a disease may be after the life-history of the parasite causing it is fully known. Katayama disease was first described by Fujii in 1847, but it was not known to be due to the presence of the oriental blood-fluke until 1904, when the worms were found in man by Japanese investigators. During the next three years the effects of the worms on the human body were fully worked out, but the method of infection was still unknown. Contaminated drinking water was thought to be the

most probable method, but by an ingenious series of experiments Fujinami and Namakura in 1909 proved that the parasites gained entrance to the body through the skin. Many Japanese investigators were by this time profoundly interested in this problem and by the end of the next four years the entire life-history of the organism had been worked out, especially by Miyairi and Suzuki, a life-history similar in many ways to that of *Clonorchis sinensis*. The eggs that are passed in the feces hatch in the water, giving rise to ciliated miracidia. These swim about until they come in contact with a certain species of snail into which they bore their way. Within the snail they undergo rapid multiplication, finally emerging in a form resembling a minute fork-tailed tadpole. These little organisms then lie in wait for any animal they may chance to come in contact with, whereupon they penetrate the skin, make their way into the blood stream and finally reach the liver, where they grow into adult worms. The solution of the purely zoological problem of the life-history of this worm accomplished for the Katayama disease what the elucidation of the transmission of the malarial organisms by mosquitoes did for malaria—it furnished a means of attacking the intermediate host. This was immediately begun and it was soon discovered that the addition of lime to the water resulted in the death of the snails and without the snails the worms could not complete their life-cycle successfully and were hence destroyed. Between the years 1913 to 1923 the Katayama disease was practically eradicated from its original home by the elimination of the intermediate host, the snail.

The knowledge gained by the study of the oriental blood-fluke by the Japanese immediately enabled other investigators to solve the problems presented by blood-flukes in other parts of the world. All that needed to be done was to determine the species of snail that acted as intermediate host and by destroying these snails prevent the production of the infective stages of the parasite. This method will probably in time bring about the eradication of all human blood-flukes.

Another disease whose conquest may be placed to the credit of medical zoology is bubonic plague. Epidemics of this disease have occurred from time to time in various parts of the world. In the 14th century one fourth of the population of Europe died of plague, and a similar catastrophe might have overtaken the United States when this disease was introduced into San Francisco in 1900 if we had not known how to control it. The plague germ was discovered by Yerson in 1894 and found to be the same as that occurring in rats. In 1905 Liston noted the growth and multiplication of these germs in rat fleas, and in the following year the British Plague Commission in India proved the rat flea to be the principal transmitting agent. Epidemics of plague can now be prevented by destroying rats and rat fleas. This was done by the U. S. Public Health Service in the San Francisco epidemic; over a million rats were caught, examined and destroyed. Unfortunately the ground squirrels in certain parts of California became infected and over twenty million of them were killed also before the disease was considered under control. As a result of these efforts only 187 cases of plague in man occurred in the California epidemic. Within the past month plague has again broken out in California, but our knowledge of the transmission of the disease will undoubtedly make it possible to prevent its spread and thus save the lives of thousands of persons.

Other insects besides the flea that serve as vectors of human diseases are phlebotomus flies that carry three-day fever and are suspected of transmitting Verruga Peruviana and cutaneous leishmaniasis; culicine mosquitoes that carry filariasis as well as yellow fever and dengue; tsetse flies that are the vectors of sleeping sickness; house flies that distribute the germs of typhoid fever and similar diseases; assassin bugs that carry Chagas fever in South America; and lice which have been proved to be vectors of relapsing fever, typhus fever and trench fever. Nearly related to these insects are the ticks which carry relapsing fever and Rocky Mountain spotted fever.

The most recent and in many ways the most remarkable conquest of disease due to parasitic organisms presents an example of a house divided against itself, since one parasite is engaged to combat another parasite. The disease called general paralysis, paresis or softening of the brain has been known and dreaded for centuries. It is the result of infection with the syphilitic organism, *Treponema pallidum,* and is a form of insanity characterized by the gradual loss of the mental faculties, followed by dementia, death taking place usually in from a few months to five or six years. Wagner von Jauregg, of Vienna, discovered in 1920 that malarial organisms, when inoculated into patients suffering from general paralysis, brought about a distinct improvement in the course of this disease. Patients were allowed to go through eight or nine malarial paroxysms; were then treated with quinine to check the malaria; and were finally given six injections of neosalvarsan, which is a specific therapeutic agent for syphilis. Von Jauregg reported 120 completed cases. Of these, 30 were discharged from the hospital as cured and 51 were greatly improved but not entirely cured. What the mechanism of these cures is is not known, but the

theory is that malarial immune bodies are produced which activate the protective powers of the body against paresis.

These investigations naturally stimulated similar studies in other parts of the world, the results of which are now appearing in scientific periodicals. Among these is a recent report by Yorke and Macfie, of the Liverpool School of Tropical Medicine. Eighty-four patients suffering from general paralysis were studied by these investigators, and sufficient time has elapsed since their experiments were begun to furnish definite results. The physical and mental condition of 23 of these patients improved so much that they were discharged from the hospitals; great physical and distinct mental improvement was observed in 17 of the patients; a physical gain but no mental progress was noted in 10 cases; and although no noticeable change was evident in 20 of the patients, many of these would have died if they had not been infected with malaria. The fact also should be emphasized that no patient suffering from general paralysis had ever previously been discharged from the hospitals in which Drs. Yorke and Macfie carried on their experiments. Here then is the malarial organism, which causes one of the most important diseases of man, being employed to cure another and even more dreadful parasitic disease.

It is interesting to note the rapid progress that has been made in the control of diseases due to animal parasites throughout the world, and it is gratifying to us to realize that an American institution is the foremost leader in this movement. I refer to the Rockefeller Foundation. This foundation grew out of the discovery by medical zoologists that much of the shiftlessness and misery among certain classes of people in our southern states was due to hookworm disease. The clinical symptoms of hookworm disease, including dirt-eating, laziness and anemia, were described from Louisiana as early as 1821, and fragmentary reports of the finding of the worms themselves were recorded at intervals beginning about 1864; but serious attention was not directed to the disease until Dr. C. W. Stiles, of the Hygienic Laboratory of the United States Public Health Service, began a series of studies which culminated in the organization of the Rockefeller Sanitary Commission in 1909. The control of hookworm disease is a relatively simple matter, but Dr. Stiles and the commission were subjected at first to much ridicule, which, however, gave way to praise as soon as the quick and revolutionary results of their work began to appear. Great progress was made during the four years this commission was in existence. At the end of this time (1913), the Rockefeller Foundation was established, with an initial endowment of $100,000,000, for the purpose of promoting "the well-being of mankind throughout the world," and one of the first acts of this foundation was the reorganization of the Rockefeller Sanitary Commission as the International Health Board. Among the principal objects pursued by this board have been the control of hookworm disease, malaria and yellow fever. Nearly $4,000,000 were spent from 1913 to 1923 for the relief and control of hookworm disease, over $1,000,000 for yellow-fever control and almost $800,000 for malaria control. The indirect results of this work have probably been no less important than the direct decrease in the incidence of these diseases in the areas covered, since permanent public health activities of various sorts, supported entirely by the people concerned, have grown out of these campaigns for the control of diseases due to animal parasites.

Much of this work has been done in tropical and semi-tropical countries largely because diseases due to animal parasites increase in number and variety as one approaches the equator—a condition resulting from a combination of favorable factors. Transmission from one host to another is easier in the tropics than in the north, where the infective stages of the organism are often subjected to freezing temperatures; sanitary conditions are usually less rigid in the tropics, thus facilitating the spread of disease, and the transmitting agents, such as mosquitoes, are active almost continuously throughout the year. In the north many diseases of animal origin have almost entirely disappeared because the breeding places of the transmitting agents have been eliminated by intensive cultivation of the soil; and pollution of the soil is prevented by modern plumbing. Residents of rural districts in the north, where sanitary measures are not as strictly enforced as in the cities, are more frequently infected than those of the cities, but even in the latter there is a surprisingly high incidence of infection with certain animal parasites. For example, Dr. G. C. Payne and I compiled data contained in the literature for about twenty thousand cases which had been examined for intestinal protozoa, and found that 20 per cent. were infected with *Endamoeba coli*, 12 per cent. with *Giardia lamblia*, 9 per cent. with *Endamoeba hystolytica*, 4 per cent. with *Chilomastix mesnili* and 3 per cent. with *Trichomonas hominis*. I have no doubt but that this average would be found to hold among the members of my present audience. Fortunately these organisms are not usually pathogenic.

Facilities for rapid transit have made of public health a world problem. Disease-producing organisms may be transported from one locality to another and for long distances either by human carriers or by the intermediate hosts. A human carrier is a

person who is infected and thus carries the parasites from place to place on or within his body but who does not exhibit symptoms of disease. Carriers more or less unconsciously distribute the infective organisms and are responsible for spreading infectious diseases among susceptible persons. The intermediate hosts of animal parasites are usually lower animals, such as cattle, dogs, snails and insects; these are also frequently transported from one country to another. It has not always been necessary, however, to take drastic action for the purpose of preventing the importation of animal parasitic diseases into the United States because of their complicated life-histories. Malaria can not be transmitted in a locality where certain species of anopheline mosquitoes are absent, even if persons with malarial parasites in their blood are present in large numbers. The Katayama disease of Japan can not gain a foothold in this country, even though many infected Japanese are allowed to enter, because the species of snail which acts as the intermediate host of the oriental blood fluke does not exist in the United States. The habits of the general population have a considerable influence on the spread of parasitic diseases. For example, the lung fluke, *Paragonimus westermani,* which is also a common parasite in Japan, depends for its transmission upon the peculiar habit of certain orientals of eating certain fresh water crabs raw in which are the encysted stages of the fluke all ready to start a new infection in any one who swallows them. We in the United States are safe from this parasite because we do not eat raw crabs. We, however, place ourselves in danger whenever we visit foreign countries, particularly in the tropics. One must be careful when in certain parts of China, Japan and Egypt to avoid water for bathing purposes that may contain the infective stage of the blood fluke. It is necessary also to see that all uncooked vegetables are thoroughly cleansed in order to escape ingesting hookworm larvae and cysts of the dysentery amoeba and of intestinal flagellates. More precautions must also be taken to avoid being bitten by mosquitoes that may transmit malaria, yellow fever, dengue and other diseases.

It is evident that one field in which medical zoology has taken the leading rôle is that of rendering the tropics as habitable for man as are the temperate regions of the earth. I have already described the conquest of malaria and yellow fever and shown how Havana, Cuba and the Panama Canal Zone were transformed into healthful districts by putting into operation simple control measures perfected from the results of scientific investigations. All this has a distinct bearing upon one of the greatest problems before mankind at the present time—the problem of population. Statistics show that the world's population has increased about two and one half times during the past century. Population is continuing to grow and millions of acres of new lands must each year be made productive in order to keep mankind from hunger and starvation. Many methods of preventing further increases in population have been suggested and no one can predict what the future may have in store for us in this direction. We must, however, face the problem that confronts us to-day, and this problem involves the opening up of new land every year. In tropical America and in other tropical countries large areas of fertile country exist that are now unproductive. That these tropical regions can be made healthful to men from the colder regions of the earth has been proved again and again by various nations that have founded colonies in the torrid zone. To do this it has only been necessary to control certain diseases, and these diseases have been for the most part due to animal parasites or their transmitting agents.

During the past summer I obtained a first-hand knowledge of conditions in tropical America, having visited plantations and hospitals in Cuba, Jamaica, Guatemala, Honduras, Costa Rica, Panama and Colombia. The number of deaths and extent of the sickness and misery due to diseases of animal parasitic origin was quite startling. In fact the principal difference between the diseases of the American tropics and those of the northern United States is the prevalence in the former of maladies due to infections with animal parasites. Statistics gathered together by the doctors in the nine divisions of the United Fruit Company show that malaria alone was responsible in 1923 for 38 per cent. of 27,654 cases treated in their hospitals, and that 205 of every thousand employees were admitted to their hospitals with malaria and that ten of every thousand deaths were due to this disease. Hookworm disease is more insidious than malaria; it does not bring about sudden prostration but slowly saps the vitality of its victims; hence, although it is probably as widespread, hospital admissions due to its ravages are not so frequent; nevertheless 5 per cent. of the hospital cases were suffering from this disease. A third cause of sickness and death is amoebic dysentery. In 1923, 420 cases of amoebic dysentery were treated in the hospitals of the United Fruit Company, and a large proportion of these patients failed to recover, principally because the disease was in an advanced stage when treatment was begun. Not infrequently natives are encountered in tropical America who are veritable museums of medical zoology. Many of them are chronically infected with from one to three species of malarial parasites, with two or more species of

intestinal amoebas, with several species of intestinal flagellates, with hookworms and from two to four other species of worms, and externally with several species of parasitic insects. Undoubtedly the tropics offer a happy hunting ground for medical zoologists as well as for public health workers. Here are vast areas that may be made habitable by the introduction of control measures that have already been perfected and are very simply put into operation.

Before concluding my lecture I should like to say a few words about where work in the field of medical zoology is being done. In the first place, much of the subject known as tropical medicine is devoted to the study of diseases due to animal parasites, hence we find medical zoology the most important subject in schools of tropical medicine such as those at London, Liverpool, Brussels, Amsterdam and Hamburg. In this country investigators in the field of medical zoology are working in the U. S. Public Health Service, the U. S. Department of Agriculture, in various institutions, such as the Rockefeller Institute, and in colleges and universities. Physicians, especially those living in tropical or semi-tropical countries, are also continually adding to our knowledge of animal parasites and human disease.

The successful control of such diseases as malaria, yellow fever, hookworm disease, plague, Katayama disease and many others is very gratifying to medical zoologists, since millions of human beings have thus been saved from suffering and death. But there are still many diseases that are only partly under control and about which very little is known. Even malaria, which has been studied for many years by some of the best of our scientists, still offers many problems for solution. It sometimes seems that we will never know all there is to be learned about any one of these diseases, but as Pasteur, who was at least in part a medical zoologist, remarked, "To travel hopefully is a better thing than to arrive, and the true success is to labor."

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## THE RUMFORD FUND

The following is a brief history of the Rumford Fund, as well as of the purposes for which it was created and has been maintained.

Benjamin Thompson was born at Woburn, Mass., in 1753, and studied at Harvard College, being much interested in scientific subjects. He was a teacher in schools at Wilmington, Mass., and at Rumford, N. H. He went to England in March, 1776, and carried on there a series of scientific studies, the results of which were communicated to the Royal Society. He was elected a fellow of that society in 1779.

In 1785, he entered the service of Prince Maximilian, the Elector of Bavaria. He introduced a number of important reforms into that country, while also carrying on an important series of scientific researches. One result of these researches was a demonstration of the equivalence between heat and mechanical work. He reclaimed a large area of barren land at Munich, and formed it into a fine park, which he subsequently gave to the city and which is still known as the "English Garden." In 1791, he was invested with the rank of a Count of the Holy Roman Empire, and chose the title of Rumford, the New Hampshire village in which he had taught as a youth, and in which the family of his wife had resided.

In 1802, he removed to Paris, where he met and married his second wife, who was the widow of the celebrated chemist, Lavoisier. It was in 1794 that the French revolutionary government had sentenced Lavoisier to death under the guillotine, at what is now the Place de la Concorde in Paris.

Count Rumford founded the Rumford Research Medals of the Royal Society in London and of the American Academy of Arts and Sciences in Boston. He also founded a Rumford professorship in science at Harvard University. During his life, he made numerous contributions to economics, physics, meteorology and chemistry. He died at Auteuil, Paris, in 1814.

The American Academy of Arts and Sciences has continued to administer the Rumford Fund, by awarding premiums and grants, in aid of researches in light and heat. The academy maintains a standing committee of seven fellows, known as the Rumford Committee. This committee, from time to time, recommends to the academy the award of the Rumford premium or medal to persons in North America or any of the American islands, who have notably contributed to the sciences of heat or light. The committee also considers all applications for grants from the income of the fund in aid of research connected with those sciences.

Since 1839, the academy has made thirty-two awards of the Rumford premium to scientific investigators. It has also made nearly 250 grants of money to researchers, varying in amount between \$25 and \$750, but averaging about \$260 each. These grants are for apparatus, materials or experimental equipment. They are also made towards costs of printing in the publication of researches. Only in very rare cases have grants been made towards the payment of assistants in carrying on such researches.

The subjects of research aided by the Rumford Fund are light and heat. More recently, the subject of X-rays has been accepted as coming within the scope of the fund.

Recipients of grants for investigations are ex-

pected to report annually to the committee as to the progress of the work for which the grant was made.

Researches carried on with aid from the Rumford Fund may be published in any place or form, with the proviso that due recognition be made of the grant as from the Rumford Fund of the American Academy of Arts and Sciences. It is expected that a complete copy of every such publication shall be presented to the academy.

Persons making application for grants from the Rumford Fund are expected to inform the committee of any similar applications made by them for grants from other funds in aid of the same research, or of related researches.

Applications for grants should be addressed to the Chairman of the Rumford Committee, Care of the American Academy of Arts and Sciences, 28 Newbury Street, Boston. Such an application may be made by any duly qualified person in North America or in any of the American islands. It should specify the nature of the research and the particular aid desired.

A. E. KENNELLY,
*Chairman of the Rumford Committee*

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## EDMUND OTIS HOVEY (1862–1924)

THE unexpected death of Dr. Edmund Otis Hovey, for many years curator of geology of the American Museum of Natural History, New York City, came as a severe shock to the geologists of America. For a generation he had been a familiar figure in the councils of the leading organizations fostered by investigators in the science of geology, and his service in them has left an impress that will last for many years. Few men had a greater number of personal friends in his own field or a wider acquaintance in his science the world over. His passing has given a distinct sense of personal loss to a host of people, far beyond the bounds of intimate family ties and friend-associates. It is well to stop and pay tribute to the memory of such a man.

Edmund Otis Hovey was born of New England parents, in New Haven, Connecticut, September 15, 1862. After a career of great usefulness and activity, which continued unto the very day of his death on September 27, 1924, his life work came to a sudden end in the midst of a busy day, almost as any very active man might wish.

By inheritance, training and subsequent opportunity, Dr. Hovey was marked for geological service, and few men in the field of geology in America have filled their niche better. His father, Horace Carter Hovey, before him, was deeply interested in geologic phenomena, but was a minister of the gospel by profession, a calling which he followed all his days. The scholarly atmosphere of the parsonage, coupled with a deep love of scientific investigation, furnished a favorable environment.

To this helpful environment of youth and to his native talent were later to be added a training that could not readily be surpassed and an opportunity far superior to that vouchsafed to most men of scientific bent. It is true that his preparatory education was somewhat broken by the many moves of the family to different places in the Middle West and in New England, but the cities and towns to which his father was called to preach were among the better places of those days. Even this experience was but a foretaste of travels to many distant lands that it became his own lot to visit and study in later years.

He attended Yale College in the days of the elder Dana, one of the great masters of earth science in America and it was in such surroundings that he began to formulate plans for a scientific career. After finishing his college course he was for two years a teacher and principal in the schools of Minnesota; but was not content to follow that call, and in 1886 he returned to Yale for graduate study in geology and mineralogy, securing the degree of doctor of philosophy in 1889. Additional years of teaching and school administration were followed by travel and study abroad, where he came in touch with some of the most famous scientists of Europe, notably with Professor Rosenbusch, the most eminent petrographer of his day, whose influence seems to have followed him the rest of his life. From that time he devoted himself to scientific work in his chosen field, to the organizing of geologic data for educational purposes and ultimately to very distinguished service as an editor and as the chief responsible officer of one of the greatest scientific societies.

The first step was taken in 1893 when he was placed in charge of the Missouri State exhibit of minerals at the Columbian Exposition in Chicago. The ability displayed in that engagement attracted the attention of museum directors; and at the invitation of the American Museum of Natural History, New York City, he accepted a position on the geological staff of that institution, where he served the rest of his life. It was neither luck nor favor, but a perfectly natural outcome for a man who had already proved his mettle and had made good on the first opportunity presented.

His years at the American Museum carried him through all grades and many kinds of service to a curatorship in charge of the department of geology, one of the highest scientific responsibilities in that organization, which post he held for fourteen years. In the course of his service at the museum an enormous amount of work had to be done in making the immense collections of that institution of greatest usefulness both to scientists, who look to it for com-

parative material and to the general public, who look to it for guidance and instruction.

His skill in the organizing of material for the latter purpose never forsook him, and he was engaged on undertakings of this kind to the last day of his life. The writer of this memorial note was in consultation with him several times within the last month, working carefully over an exhibit of the geology of New York City; and at the time he was stricken, Dr. Hovey was about to start on a field trip to gather additional information for a similar purpose. While it is always difficult to measure the value of service of this kind, it is not at all difficult to see the effect it has if one will but watch the endless procession of visitors who pass through the corridors of the museum.

Dr. Hovey was instrumental in establishing *The American Museum Journal,* the forerunner of *Natural History,* and for ten years he was its editor. At the same time he was secretary of the New York Academy of Sciences and editor of its "Proceedings" and "Annals." In 1907 he was elected secretary of the Geological Society of America, and thereby became the most influential member and the chief executive officer of that important organization. For sixteen years he held this post and discharged its arduous duties with marked success. The demands of these several organizations finally became so exacting that he found it advisable to retire from them all to give undivided attention to his museum duties and to his unfinished researches. He proposed to devote the rest of his life to publishing the results of years of exploratory experience, much of which, in the press of these other duties, had been crowded into the background.

In spite of his many official duties, however, he had managed to write more than one hundred and fifty scientific papers, covering a great variety of subjects within his chosen field and representing field studies that touched many foreign countries. He was an authority on volcanic phenomena. Through his two years of enforced stay in the Arctic he had opportunity to make observations along the Greenland border, and in his very last year he visited Australia as the guest of the Third Pan-American Scientific Congress, on special invitation of the geologists of Australia. One of his best-known contributions was his study of Mt. Pelé in Martinique, which he visited immediately after its eruption and twice thereafter.

Dr. Hovey was twice married. His first wife, Miss Esther A. Lancraft, who died in 1914, was an active helper during her lifetime in his many interests. In 1919 he married Miss Dell G. Rogers, who, with a young daughter, Constance, survives him.

Dr. Hovey had unusual fitness for the type of service that he was called on to render to the science of geology. As secretary of the Geological Society of America he came into close relations with all the leading geologists of the United States and could count them as his personal friends. As head of the department of geology of the American Museum of Natural History and organizer of its impressive exhibits he touched the millions of visitors who pass through that institution. It is difficult to fathom the extent of his influence—so much of it went into the building of a better educational science service rather than to more tangible product. In this field he was a very distinguished man and every geologist in America feels the shock of his death. It is difficult to realize that the wise counsellor of more than a generation has passed away.

Charles P. Berkey
Columbia University

## SCIENTIFIC EVENTS

### RESOLUTION OF THE INDIANA ACADEMY OF SCIENCE

At the annual meeting of the Indiana Academy of Science held at Purdue University, LaFayette, Indiana, December 4 and 5, the following resolution was passed with the request that it be sent to Science for publication:

Whereas, In reviewing the literature on various biological subjects, members of the Indiana Academy of Science have noted the following bad practices on the part of various authors and publications:

(1) That in giving bibliographic references some authors cite merely the volume and the page of the publications, but omit the date;

(2) That authors do not fully index all species and synonyms mentioned in their work, but are often content to index merely the valid genera as they see them;

(3) That reviews and scientific articles are often signed with the initials and not the name of the author so that the bibliographer is often at a loss to know who the author is;

(4) That the date of publication of some of the prominent scientific serials is printed on the cover page instead of on a numbered page of the issue, which makes necessary the binding of said cover and the advertisements;

*Therefore,* Be it resolved by the Indiana Academy of Science at its fortieth annual meeting that such practices as have been enumerated above be heartily disapproved and that the following suggestions for the benefit of all scientific workers are hereby approved:

(1) That all authors give the volume, page and date of publication when referring to publications;

(2) That all authors index fully all species, genera and synonyms mentioned in their work;

(3) That the full name of the reviewer or author be signed to all reviews or scientific articles;

(4) That all scientific publications print the date of publication on a numbered page either at the beginning or the end of the scientific matter so that the binding in of the cover and advertisements will not be necessary.

## NEW GIFTS TO EDUCATION

Forty-six million dollars have been given to the creation of a trust fund by James B. Duke to be used for educational, charitable and religious purposes, chiefly in the states of North and South Carolina.

Announcement of the fund, to be administered by fifteen trustees as a self-perpetuating body, was made by Mr. Duke, who in specifying the institutions and purposes for which the fund will be used, said the securities set aside for it include about three fourths of his holdings in the Southern Power System.

The fund contains an alternative provision by which Trinity College at Durham, N. C., may have $6,000,000 of the total to be used in its expansion if it elects to change its name to Duke University. Otherwise, the trustees are directed to spend not more than that amount in establishing a Duke University in North Carolina.

Providing for retention of twenty per cent. of the annual income on the remaining $40,000,000 to be added to the principal until it amounts to $80,000,000 the plan specifies the division to be made of the remaining income, with 32 per cent. to go to Duke University for "all purposes" and an equal percentage to the building and maintenance of hospitals, chiefly in North and South Carolina. Smaller percentages are alloted to charitable work among whites and negroes in the two states, to the Methodist Episcopal Church in North Carolina and to other educational institutions in the two states.

Bringing his total known benefactions to $58,602,900, George Eastman, head of the Eastman Kodak Company, has announced new gifts of $12,500,000 to institutions of higher education, after recently announcing a gift of $2,500,000 in the greater University of Rochester campaign. Those to benefit under the latest gifts of Mr. Eastman are: Massachusetts Institute of Technology, $4,500,000, which is added to a previous gift of $11,000,000; University of Rochester, $6,000,000; Hampton Institute, $1,000,000, and Tuskegee Institute, $1,000,000.

Of Mr. Eastman's total of $58,602,900, the sum of $23,578,500 has been given to the University of Rochester, making this institution the largest single recipient of his gifts.

Gifts just made and not announced before are under terms similar to those made to employees. Stock is sold to benefiting institutions for $12,500,000 less than its actual value. While provision is made that it may be paid for in installments during the life of Mr. Eastman, it is given without any restriction regarding the time for sale. It may be sold at once if the beneficiaries desire to part with it.

## PLANS FOR THE NEW YORK BOTANICAL GARDEN

Expenditure of approximately $7,000,000 to make the New York Botanical Garden a model for the world is contemplated by the Board of Managers, whose plans have been announced by the president of the board, Dr. Frederic S. Lee, 437 West Fifty-ninth Street, research professor of physiology at Columbia University. The announcement explains that "endowment, equipment, maintenance and research are among the purposes to be advanced," and then says:

> The realization of the requirements for adequate maintenance, needed improvements and desired advance would place the New York Botanical Garden in a position of leadership in this country, if not in other countries, in matters that deal with plants in their various scientific, esthetic and economic relations to man.
>
> The garden would then stand conspicuous among the best of the public institutions of the city. To enable it to assume this rightful position its funds must be largely increased, and chiefly by private beneficence.
>
> The actual amount of money required would be approximately $7,000,000, in the form partly of moneys to be directly expended, and partly of increased endowment. The more urgent needs demand the sum of $4,000,000, of which $800,000 should be expended for material improvements and equipment and the remainder be added to the endowment.
>
> The Board of Managers is making an effort to obtain this needed $4,000,000, and confidently looks to the people of New York to contribute it.

## PROGRAM ON THE HISTORY OF SCIENCE AT WASHINGTON

There will be a joint meeting of Section L, of the American Association for the Advancement of Science, and the History of Science Society at Washington on December 31 and January 1, at which the following program will be presented:

Wednesday, December 31, 1924, at 2 P. M.

Room 24, Corcoran Hall, George Washington University

Dr. L. J. Henderson,
of Harvard University, presiding

*Development of the present day conception of palaeontological history:* Dr. John C. Merriam, president of the Carnegie Institution of Washington.

*Arabic science in Christian Europe:* Dr. Charles H. Haskins, professor of history, Harvard University.

*Study of medieval science:* Dr. George Sarton, research associate, Carnegie Institution of Washington and lecturer of the History of Science, Harvard University.

*The life and work of Dr. William A. Locy (the first chairman and vice-president of Section L [History of*

*Science*], *A. A. A. S.*): DR. C. E. THARALDSEN, professor of zoology, Northwestern University.

Council meeting of the History of Science Society, Cosmos Club, 7 o'clock P. M.

THURSDAY, JANUARY 1, 1925, AT 2 P. M.

Room 24, Corcoran Hall, George Washington University

DR. L. C. KARPINSKI,

of the University of Michigan, presiding

*Leibnitz, the master builder of mathematical notations:* DR. FLORIAN CAJORI, professor of history of mathematics, University of California.

*Benjamin Peirce:* DR. R. C. ARCHIBALD, professor of mathematics, Brown University.

*The natural sciences in the University of Paris during the Middle Ages:* DR. L. J. PAETOW, professor of history, University of California.

*The study of western science of the fourteenth and fifteenth centuries:* DR. LYNN THORNDIKE, professor of history, Columbia University.

FREDERICK E. BRASCH,

*Secretary of Section L (History of Science), A. A. A. S., Assistant Secretary of the History of Science Society*

## SCIENTIFIC NOTES AND NEWS

DR. DAVID STARR JORDAN, chancellor emeritus of Leland Stanford University, has been awarded the prize of $25,000 offered by Raphael Herman, of Washington, for the best educational plan calculated to maintain world peace.

AT a meeting of the Royal Society, London, on December 1, it was announced that a third research professorship has been provided from the munificent gift from their fellow, Sir Alfred Yarrow. To this professorship, Professor O. W. Richardson, noted for his work in relation to the emission of electrons from hot bodies, has been appointed.

AT a meeting of the Royal Society, London, on December 1, the following officers and members of council were elected: *President,* Sir Charles Sherrington; *treasurer,* Sir David Prain; *secretaries,* Mr. W. B. Hardy and Mr. J. H. Jeans; *foreign secretary,* Sir Richard Glazebrook; *other members of the council,* Sir Frederick Andrewes, Professor J. H. Ashworth, Dr. F. W. Aston, Sir William Bragg, Professor S. Chapman, Sir Dugald Clerk, Dr. H. H. Dale, Professor F. G. Donnan, Professor A. S. Eddington, Professor E. S. Goodrich, Sir Thomas Holland, Professor J. B. Leathes, Professor T. R. Merton, Dr. G. C. Simpson, Professor J. F. Thorpe and Professor F. E. Weiss.

EMILE PICARD, professor of mathematics at the University of Paris and secretary of the Academy of Sciences, has been elected to membership in the French Academy in the place of Charles de Freycinet.

DR. ROKSABRO KUDO, of the department of zoology of the University of Illinois, had conferred upon him the degree of *Rigaku-hakushi* (D.Sc.) by the department of education of the Nihonese government, through the Tokio Imperial University, in recognition of his work in protozoology.

AT the meeting of the French Academy of Medicine on November 4, Professor Vallée, director of the research laboratories of the University of Agriculture, was elected a member.

AT a recent convocation at Whitman College, the members of the Alumni Association who had taken their major work in biology arranged a special program in recognition of the twenty-five years of service to the college of Professor H. S. Brode. The recognition included the presentation of a gift as well as words of appreciation.

ON the occasion of the completion on October 1 of twenty-five years of service to Teachers College, Columbia University, of Dr. Maurice A. Bigelow, professor of biology at Teachers College and director of the School of Practical Arts, a group of his colleagues met at his office, and Dr. Benjamin R. Andrews, associate professor of household economics, spoke in appreciation of Dr. Bigelow's work for the college.

DR. CHARLES P. EMERSON, dean of the Indiana University School of Medicine, Indianapolis, has been elected president of the National Committee for Mental Hygiene, to succeed Dr. William H. Welch, director of the School of Hygiene, of the Johns Hopkins University.

VACANCIES on the board of trustees of the Carnegie Institution, caused by the resignation of Cleveland H. Dodge and the deaths of William L. Hutchinson, Senator Henry Cabot Lodge and Robert S. Woodward, were filled by the elections of Secretary Mellon, Speaker Gillett, of the House, William Benson Storey, of Chicago, and Cass Gilbert, of New York City. The resignations of Charles P. Fenner and Henry P. Walcott were received and these vacancies will be filled next year.

DIRECTOR PAUL M. LINCOLN, of the School of Electrical Engineering, of Cornell University, was called to Philadelphia on November 25 to attend the first meeting of the program committee for the International Engineering Congress, to be held in that city in 1926.

AT the annual meeting of the New York Academy of Medicine officers were elected for the coming year as follows: *President,* Dr. Samuel A. Brown; *Vice-*

*president,* Dr. Frederick T. Van Buren, Jr.; *Trustee,* Dr. George D. Stewart; *Recording Secretary,* Dr. Fenwick Beekman.

At the October meeting of the French Academy of Sciences, M. Deslandres, director of the Astronomical Observatory of Meudon, was elected a member of the scientific section of the National Meteorological Office, to take the place of the late Professor J. Violle.

Dr. Alfred E. Cohn, of the Rockefeller Institute for Medical Research, who has accepted a three months' appointment as visiting professor of medicine at the Peking Union Medical College, China, sailed for Europe on December 17. He will proceed to China by way of Suez, arriving about April 1.

According to the *Journal* of the American Medical Association, Dr. G. Dumas was the first exchange professor reaching Mexico since the foundation of the university exchange between France and Mexico. The arrangement is that two French professors are to lecture in Mexico in July, August and September. An honorary degree was conferred on Dr. Dumas, and he was elected an honorary member of the Mexican Academy of Medicine.

Dr. George B. Cressey, assistant professor of geology in Shanghai College, has returned to Shanghai after extended geological reconnaissance in Kansu, Mongolia and Tibet. During a four-month trip from Peking, physiographic and structural studies were carried on in the Ordos and Alashan Deserts and around Lake Koko Nor.

Dr. L. S. Fridericia, professor of hygiene in the faculty of medicine of the University of Copenhagen and an official adviser of the State Board of Health, Denmark, one of a group of five Scandinavian health officials who have been making a study of public health administration in the United States under the auspices of the International Health Board of the Rockefeller Foundation, sailed for France on December 3. Two other members of the group, Dr. H. M. Gram, chief medical officer of the Health Department of Norway, and Dr. Andreas Diesen, assistant director of the Health Department of Christiania, left on December 9.

Miss Beatrice Monk, matron of the London Hospital, an institution having the largest training school for nurses in England, has spent the past five weeks in the United States and Canada as the guest of the Rockefeller Foundation, for the purpose of visiting hospitals and nurse training schools. Miss Monk returned to England on December 13.

The announcement cabled from Paris of the death of Professor Bergonié, the French radiologist, is incorrect. He is seriously ill from burns received in the early days of X-ray experimentation. He has presented to the Bordeaux Faculty of Medicine the sum of 100,000 francs for the construction and installation of an institute in connection with the cancer campaign. M. Bergonié has been raised to the rank of the Grand Cross of the Legion of Honor by the French government.

Professor W. M. Davis will spend the winter in California where he will lecture on geographical problems at the University of California, both at Berkeley and at the Southern Branch in Los Angeles, at the museum in San Diego, at the Scripps Institute at La Jolla and at Stanford University. During his westward journey he gave lectures at the Southern Methodist University in Dallas, at Rice Institute in Texas, and the University of Arizona.

Dr. W. Lee Lewis, director of the department of scientific research of the Institute of American Meat Packers, recently lectured before the local sections of the American Chemical Society at Rochester, Akron, Columbus, St. Louis and Kansas City, on the subject of "The professor in the packing industry." Dr. Lewis is on a leave of absence from Northwestern University for the purpose of organizing the department of scientific research of the Institute of American Meat Packers.

On November 29, Dr. Frederick K. Morris, geologist of the third Asiatic Expedition of the American Museum of Natural History, delivered an address before the Royal Canadian Institute on "Central Asia as the birthplace of man."

Dr. Lauge Koch, explorer and geologist, of Copenhagen, Denmark, addressed the department of geology of the University of Chicago, on November 20, on "New features of the physiography and geology of Greenland."

Dr. William H. Howell, professor of physiology and assistant director of the school of Hygiene and Public Health of the Johns Hopkins University, addressed the Institute of Medicine of Chicago on November 28 on "Problems in blood coagulation."

Dr. Leo H. Baekeland, president of the American Chemical Society, gave an address before the members of the Pittsburgh section of the society on November 21, dealing with the subject of "Misdirected energy" and reviewing briefly the history of the rise of the chemical profession.

Colonel E. B. Vedder, of Edgewood Arsenal, delivered an address on "The toxicity of lead tetraethyl and other substances" at a joint meeting of the Washington Academy of Sciences, the Baltimore Section of the American Chemical Society, the Chemical Society of Washington and the Medical Society of the Dis-

trict of Columbia, in the Cosmos Club, Washington, December 11, 1924.

THE annual dinner of the New York Academy of Sciences and its affiliated societies was held at the Waldorf-Astoria Hotel on December 15, when Dr. Clyde Fisher gave an address entitled "Across the trail of Linnaeus in Arctic Lapland."

DR. LAUDER JONES, of Princeton University, gave an address before the members of the Delaware section of the American Chemical Society, Wilmington, on November 19, on the subject "The rôle of nitrogen in inorganic and organic molecules."

DR. AXEL REYN, director of the Finsen Light Institute, Copenhagen, Denmark, recently gave a lecture at the University of Buffalo on "Light therapy."

A LARGE bronze tablet, designed by the Boston sculptor Bashka Paeff, and set in the wall in the reception room, Boston Psychopathic Hospital, in memory of Dr. Elmer Ernest Southard, was unveiled with appropriate ceremonies on November 18. Dr. Southard, formerly professor of psychiatry and neurology at Harvard University, who died in 1920, was the founder of the Boston Psychopathic Hospital and its first director.

STEPS have been taken to place a bronze *bas-relief* of the late Mrs. Ellen H. Richards, with suitable inscription, in an appropriate location in one of the buildings of the Massachusetts Institute of Technology.

THE fund which is being raised at the University of Leeds to commemorate the services of Professor A. Smithells has now reached a total of nearly £2,500. A portrait of Professor Smithells has been painted by Mr. Fiddes Watt and the presentation ceremony took place on November 25. The balance of the fund will provide a scholarship, of approximately £100 per annum, which is to be established in the university in the name and with the advice of Professor Smithells.

DR. EZRA BRAINARD, who was for twenty-five years president of Middlebury College, and earlier professor of physics, known for his contributions on the geology of the Champlain Valley and the botany of Vermont, died on December 8, aged eighty years.

DR. E. W. STANTON, formerly professor of mathematics at Iowa State College, recently died, aged seventy-four years.

DR. JOHN IRVINE HUNTER, professor of anatomy at the University of Sydney, Australia, who has been invited to give the Murphy oration at the College of Physicians and Surgeons, New York, died in London, on December 10.

DR. MAX W. HAUSCHILD, professor of anatomy at the University of Berlin, died on October 2, after his return from a research expedition to the Dutch Indies.

GERARD KALSHOVEN GUDE, of England, authority on tropical land mollusca, died on November 8, aged sixty-six years.

PROFESSOR HERMANN BRAUS, director of the Anatomical Institute, University of Würzburg, eminent for his work in experimental morphology and general anatomy, died on November 28, in his fifty-seventh year.

DR. RUDOLPH GOTTLIEB, professor of pharmacology at the University of Heidelberg, has died, aged 60 years.

THE death is announced of Dr. E. Wertheimer, emeritus professor of physiology at Lille, France.

THE Joint Genetics Sections of the American Society of Zoologists and the Botanical Society of America will present their third annual program at Washington in three sessions on December 29, 30 and 31. The titles of more than fifty papers have been received and these have been divided as follows: A session for botanical papers on Monday afternoon, zoological papers on Tuesday morning and a general session on Wednesday morning. This arrangement avoids conflict with important programs of the botanical and zoological societies on Tuesday and Wednesday afternoons. A program for geneticists interested in agriculture has been arranged tentatively for Monday morning.

THE next Australasian Medical Congress will be held in Dunedin, New Zealand, early in 1927, under the presidency of Dr. L. E. Barnett, who is retiring from the professorship of surgery in the medical school of Otago University, Dunedin. The general secretary of the congress is Dr. W. P. Gowland; the associate secretary, Professor A. M. Drennan, and the treasurer, Professor D. W. Carmalt-Jones.

THE schedule of society meetings at the Chemists Club, New York City, for the remainder of the season 1924–25 is as follows: December 5, Society of Chemical Industry, Grasselli medal; December 12, American Chemical Society, regular meeting; January 9, American Chemical Society, regular meeting; January 16, Society of Chemical Industry, Perkin medal; February 6, American Electrochemical Society (in charge), joint meeting with the Society of Chemical Industry, Société de Chimie Industrielle and American Chemical Society; March 6, American Chemical Society, Nichols medal; March 20, Society of Chemical Industry, regular meeting; April 17, Society of Chemical Industry (in charge), joint meeting with the American Chemical Society, American Electrochemical Society and Société de Chimie Industri-

elle; May 1, American Chemical Society, regular meeting; May 8, Société de Chimie Industrielle (in charge), joint meeting with the American Chemical Society, American Electrochemical Society and Society of Chemical Industry; May 15, Society of Chemical Industry, regular meeting; June 5, American Chemical Society, regular meeting.

Free lectures and demonstrations are being given at the New York Botanical Garden in the Central Display Greenhouse, Conservatory Range 2, as follows: December 6, "Fruits and seeds in winter," Dr. H. A. Gleason; December 13, "Rubber plants," Dr. A. B. Stout; December 20, "Greenhouse pests," Dr. F. J. Seaver; December 27, "A study of birds and their nests," R. S. Williams.

At the Baltimore meeting of the American Chemical Society, which will be held during Easter week, the Division of Industrial and Engineering Chemistry will hold a symposium on corrosion. At the present time the tentative outline of the symposium is as follows: 1. Submerged corrosion of metals. *a*. Iron and steel. *b*. Non-ferrous metals. 2. Atmospheric corrosion. 3. Corrosion of special alloys. It is hoped that the scope of the papers of this symposium will cover the problems of corrosion in the heavy chemical industry, in the special chemical industry, in the marine world, in ordnance equipment, in the oil industry, mining industry, etc. Papers relating to any of these subjects or subdivisions will be welcomed by the chairman of the symposium, who is Robert J. McKay.

Payment of $30,000 to the Cooper Institute, New York, for the advancement of science and art is provided for in the will of Eleanor G. Hewitt, sister of Peter Cooper Hewitt.

## UNIVERSITY AND EDUCATIONAL NOTES

A gift of $1,250,000 has been given by the General Education Board, allied with the Rockefeller Foundation, for completion of the Medical School at the University of Minnesota. The gift carries the proviso that the university obtain elsewhere $2,350,000, which will complete the $3,600,000 estimated cost of the proposed expansion.

Units of the new graduate school of medicine of the University of Chicago, projected for immediate construction, include the Billings Hospital, with 200 beds; a medical clinic for internal medicine and the medical specialties, to be occupied by the department of medicine, and a similar surgical clinic for general surgery and the surgical specialties, to be occupied by the department of pathology. This group will also house the Billings Library, a gift from Dr. Frank Billings to the university. The buildings of the physiological group, to be occupied by the department of physiology and the department of physiological chemistry and pharmacology, will be erected on the south side of Fifty-eighth Street and will connect with the hospital group.

Work will begin shortly on a $20,000 physics laboratory to be known as Founders Laboratory, it is announced at Vassar. The names of the donors have not been made public.

B. Marvel O'Harra, assistant metallurgist at the United States Bureau of Mines Experiment Station, Rolla, Missouri, was recently appointed metallurgist and acting director of the station.

Appointments to the staff of the University of Pennsylvania School of Medicine have been made as follows: Dr. George Fetterolf, professor of otolaryngology, succeeding Dr. Burton A. Randall, retired; Dr. John Claxton Gittings, professor of pediatrics, succeeding Dr. John P. Crozer Griffith, retired, and Dr. William C. Stadie, assistant professor of research medicine.

Dr. H. N. Calderwood, formerly chemist at the U. S. Forest Products Laboratory, is now assistant professor of chemistry at the University of Wisconsin. He has charge of the laboratory instruction given to engineering students. Dr. S. M. McElvain, instructor in chemistry at the university, has taken over the courses in organic chemistry formerly conducted by Assistant Professor Glenn S. Skinner, who has resigned to enter industrial work.

Dr. H. O. Calvery and Dr. H. Jensen have joined the staff of the department of chemistry at the University of Louisville, Kentucky.

Dr. L. Grant Hector, former instructor in physics and Tyndall Fellow at Columbia University, has been appointed assistant professor in physics in the College of Arts and Sciences of the University of Buffalo. Dr. P. Thomas McIlroy, of Queens University, Canada, has been appointed instructor in pathology.

Dr. Ernest Pick has been chosen to take the place of Dr. Hans Horst Meyer, professor of pharmacology at the University of Vienna, who has retired.

## DISCUSSION AND CORRESPONDENCE

### MUSSEL SHOALS

The Mussel Shoals of the Tennessee River in northern Alabama (between Lauderdale and Colbert Counties) have received their name from the immense number of species and individuals of freshwater mussels (Naiades) which used to be found at this locality. Thus the common and now official spelling "Muscle Shoals" should be discarded for the more correct one "Mussel Shoals." There is no other place upon the

whole wide world which could be compared with this one in this respect. The cause for this unusual development of Naiad-life (as well as other freshwater life) of this region is found in the fact that here two old faunas, in themselves exceptionally rich, come together, the so-called "Cumberlandian," belonging to the upper Cumberland and upper Tennessee rivers, and that of the "Interior Basin" (Ohioan fauna).

I have tried to compile a list of Naiades known from the Mussel Shoals, and have found that about 80 different species and varieties are represented here, belonging to 29 genera, and this number is increased by some additional types known from the tributaries of the Tennessee River in this region.

This extraordinary fact has been recognized at a very early time. Exactly 90 years ago, Conrad[1] wrote:

> The bivalves are . . . peculiarly abundant in those rivers of North Alabama and Tennessee, which have cut their channels in the carboniferous limestone, and where generally a long grass affords them a secure hold against the rapid current of these mountain streams. The expansion of the Tennessee River, known by the name of Muscle Shoals, is of the character I have described; it is shallow, ornamented with a number of small islands, and its bed is full of the long grass which abounds in various species of Naiades. The lover of the grand and the beautiful in natural scenery, as well as the student in science, will here find abundant sources of interest. He will be delighted with a noble river, whose beautiful and numerous islands are clothed with gigantic trees; whose high and undulating shore on the one hand is ornamented with thriving villages, and on the other spreads out an extensive alluvial, rich in all the gifts of Ceres, or rises abruptly from the river a mural escarpment of carboniferous limestone, which reflects its blue and sombre aspect in the crystal waters at its base. Like many other spots, however, remarkable for their loveliness, the subtle messengers of death have chosen it for their abode, infusing the poison of their breath into the serenity of autumn, when the transparency of the air and the purity of the sky, together with the gorgeous scenery, present at first to the unconscious traveller sensations alone of health and enjoyment.

At the present time, the above description holds good only in a small part. The beautiful islands, and the general features of the river itself are gone, as well as a large portion of the fauna, chiefly that of the mussels, which depend on the ecological conditions once presented here. For a dam has been built, the "Wilson Dam," just at the lower end of the "Little Mussel Shoals," about two miles above the town of Florence, ponding the river for many miles, and drowning entirely the "Little" as well as the "Big Mussel Shoals," beginning about four or five miles farther above. With the destruction of the conditions favorable for Naiad-life also the Naiades have been destroyed, which is so much more to be regretted, as there were forms among them which have been found only at this locality, and very likely will be, sooner or later, entirely extinct.

[1] Conrad, T. A., "New Freshwater Shells of the United States." Philadelphia, 1834, pp. 12, 13.

There are some shells yet present in this region, chiefly below the dam; but this is only a small remnant of the original richness of the fauna, and there is great danger that also this remnant will gradually disappear, due to the pollution of the waters which will be a consequence of further "improvements" connected with the dam. And then the "glory of the mussel shoals" will be entirely gone, those characteristic and unique features which would rather have deserved to be kept intact and preserved as a "natural monument," second only to very few other monuments of the United States.

Only one part of Conrad's description has been intensified and emphasized by the present conditions: this is the part which speaks of the "subtle messengers of death," undoubtedly alluding to malaria (and mosquitoes), although Conrad, of course, did not know anything about their connection. But the fact is that mosquitoes and malaria are increasing to such a degree that the inhabitants of Florence and other towns in the vicinity are becoming alarmed, and are beginning to discuss preventive measures.

Truly, a sad state of affairs!

A. E. ORTMANN
CARNEGIE MUSEUM

## AS STUDENTS UNDERSTAND IT

THE assumption of omniscience in Dr. David Starr Jordan's comments on my list of student misconceptions, published in SCIENCE of August 29, reminds me of the old story of the man who consulted a physician for relief from an irritation in his chest. "What is your profession?" asked the doctor. "I play in a brass band," answered the man. "Just the trouble!" exclaimed Medico. "I have always claimed that this excessive blowing of horns was injurious to some lungs; What instrument do you play?" "I beat the bass drum," answered the man.

No one would question the absolute necessity of laboratory contact work in any science course, and the lecture accompaniment should be and doubtless is of a summary and explanatory nature.

In all the science courses at the Virginia Polytechnic Institute, in biological matters there are laboratory courses in invertebrate and vertebrate zoology, six hours a week for one term in each, using Dr. Pratt's two manuals as laboratory guides; in botany, systematic laboratory, 6 hours a week for one term, and in advanced botany, 6 hours per week for one

term. There are also laboratory courses in entomology. The department of bacteriology requires 15 hours per week laboratory work for one term.

It is true that the agricultural students do not get the zoological laboratory, unfortunately, and here Dr. Jordan's strictures will apply; though these men get the botanical, entomological and bacteriological laboratory work.

It may be pertinent, however, to say that the student who gave the answer as to the reptile legs, which answer Dr. Jordan specifically comments upon, had had both the invertebrate and the vertebrate laboratory work and had only recently dissected, among vertebrates, shark, perch, frog, snake, turtle, sparrow and rat.

ELLISON A. SMYTH, JR.
VIRGINIA POLYTECHNIC INST.

I HAVE read the article by E. A. Smyth, Jr., in the October 10, 1924, issue of SCIENCE. This discussion is continued by David Starr Jordan, of Stanford University, who raises the question whether after all such ludicrous answers are not explained because of the use of the "lecture" system. He maintains that it is a lack of "contact" or the actual working with plants and animals which brings about a lack of appreciation, or actual knowledge in the minds of our students. In other words, he says, "the results of contact may be permanent."

I did not observe that E. A. Smyth, Jr., obtained the answers quoted as a result of the lecture system —he does not so state in his article. I agree in principle with Dr. Jordan, but in actual practice it does not necessarily work out this way. I am not at all convinced that his method of approach will overcome the lack of thinking and reasoning on the part of our freshmen or even upper classmen. I have been engaged in teaching only about one third as long as E. A. Smyth, Jr., but I have realized that many inane answers may be obtained from "contact" studies in the laboratory as well as from other methods.

"You can lead a horse to water, but you can not make him drink"; also, you can show students the way to knowledge, but you may not be able to make all of them think or reason logically. Working with the hands and using the eyes do not necessarily fix things in the minds of our students.

I am teaching a freshman class in botany this year. I would rather teach freshmen than a group of upper classmen, because they are more ready to be shown and less sophisticated. The intentions of our students undoubtedly are good. Why, then, do we get such answers? It can not be explained by any one cause. To illustrate: we have one experiment in our freshman course in botany which has been recently performed—to determine the need of water for germination of seeds. The experiment was definitely outlined and ample instructions were given. The students were supplied with honey locust seed, blotting paper and files for cutting notches in the seed coats. The students were told to perform the experiment and set the seed aside until the next laboratory class period, when they were to make an examination to see what had happened. After the results were observed, they were told that the experiment illustrated a principle involved in scarifying alfalfa and sweet clover seed to increase the percentage of germination.

In a quiz a few days later, the students were asked to describe an experiment which demonstrates the need of moisture for seed germination. Since the quiz was given a week after the experiment was performed, I am perhaps unreasonable in expecting them to retain the knowledge that long. This was one of the answers:

> The experiment in which the need of moisture for germination was the one where we took the same kind of seeds and placed them in different conditions. One batch of seeds was moistened, *placed in an oven at a hundred degrees centigrade,* while the others were left in the room at regular temperature. The ones in the oven where there was no moisture for germination were not as good as the seeds that were where moisture could get at them.

The young man submitting this answer had a hazy recollection of another experiment which he performed by "contact" and which aims to show the difference between the moisture content of air-dried seed and germinating seed.

Many of these absurd answers, but not all, could probably be explained by the fact that no matter how a course is taught, it seems to be human nature for the youngsters to have their minds on "dates," dances, parties, pep meetings and the Saturday football game while they are engaged in their work. With these things uppermost in their minds, how can we expect thinking and reasoning on the various subjects required in our curricula?

The students of Agassiz lived at a different age, distractions were perhaps not so numerous, students were probably more mature and serious minded and burning with enthusiasm to obtain knowledge. Our youngsters are "burning with enthusiasm" also, but the fire is kindled elsewhere. If Agassiz were teaching in 1924, with his classes largely composed of 16 to 17-year-old students, and if his laboratory had 25 to 30 students instead of five or six, with the present-day environment in place of that which obtained in 1874, it is scarcely a debatable question in my mind as to the nature of some of the answers he would receive.

It is perhaps unfortunate that most of our courses in science must necessarily call for facts instead of entertaining information, but I am not as yet convinced that the doing away with lecture work and emphasizing contact work will greatly improve the situation where our classes are large and the subject-matter required.

I do not, however, want to be understood as being an adherent of the lecture system. The easiest way for any of us to explain the situation seems to be to blame the other fellow—something must be wrong with our secondary schools and the age at which the boys and girls enter college. On the other hand, I believe our students have a right to question in some instances the teaching ability of the instructor. As college teachers, our greatest responsibility is not to teach our undergraduate students primarily facts, but to think. The question in each one's mind should be how this can best be accomplished under the present conditions.

L. E. MELCHERS

KANSAS STATE AGRICULTURAL COLLEGE,
MANHATTAN, KANSAS

RECENTLY SCIENCE published so-called "howlers" composed by students during examinations. While the compositions are humorous in a certain sense, yet they possess a pitiable aspect in revealing the lack of preparation in English and geography and a lack of coordination of thought, especially on the part of students entering college. The following have been selected from the writings of students in several schools and in upper classes as well as first year. The quotations are verbatim.

The preCambrian roch were where in distinct fossil were found. The rocks were mostly igneous and meta morphosed, with some sedimentation in the proterozoic Limestone was found in the rochs. which lead to evidence of life of some organism The Archean is universal and very thick. This tell it was a long period of time and equal. The proterozoic rocks have eroded some.—

Ripple marks and cross bedding are due to formation within minerals of minor minerals on thin planes.

Continental deposits are deposits formed by wind, such as the Rocky Mountains, these deposits are called stratification.

—magmas extrusively imbedded in the earth's crust.

A loess is made up of a yellowish-brown material which was peculiar to geologists.

A fossil is the historic record of the past geologic conditions of the world and the chief proof of the fact of evolution or the gradual descent of man caused by the decomposition of animals or plants in rocks under conditions favorable for preservation.

Even Bolivia may be found in young and old river valleys.

The ginkgo would have perished after the Mesozoic had it not been cultivated by the Chinese.

Trilobite is a good name because they have feelers.

Gradation is the desire of the earth to level itself.

Stages in development of streams may be compared to stages in children. In infancy they are gullies; in youth they have straight sides and narrow bottoms.

The Rockies were formed between the Cretaceous and the Plastaceous.

Relief features of the second order within the ocean basins are not much concerned with human nature.

If the La Placian hypothesis were true all planets would revolve around the sun once a year.

The agriculture is mostly mining.

WALDO S. GLOCK

THE OHIO STATE UNIVERSITY

THE examples of student misinformation submitted by Professor Smyth will doubtless start an avalanche of *Outrageous Biology* from teachers who hitherto have scarcely dared admit what is possible from their students. From my own collection of some years, one which I alternately view with delight and despair, may I submit these gems?

The liver is a capillaraceous organ whose function is to produce a fluid used in digestion and reproduction. Its outlet is the arteries.

Breathing is rhythmic because it takes so long to take in a breath and so long to let it out and we have to rest between. This is controlled by valves, which are in turn regulated by a column of mercury 760 mm in height. Thus we see that when the system is in proper working condition breathing is rhythmic.

CLEMENTINA SPENCER MOMYER

## THE RACIAL ORIGIN OF ALMSHOUSE PAUPERS IN THE UNITED STATES

IN an article under the above title which appeared in SCIENCE for October 31, Dr. Raymond Pearl says:

While on January 1, 1923, there were in almshouses 59.8 native-born white persons per 100,000 of the same class in the population, the corresponding figure for the foreign-born was 173.6. This is by some regarded as a fact of dread significance. Perhaps it is. To me it seems possibly only an interesting expression of the difficulties which the human organism finds in adapting itself to a new environment.

As an additional factor not to be overlooked I suggest that the native has relatives and old friends who would feel it a disgrace if he had to enter an almshouse and who prefer to help him along and even support him rather than endure it, while the foreign-

born left kin and early associates in another land. Such kin are apt to be poor and in any case are hardly likely to send money to support one who migrated to rich America. We can also remember the huge sums our government pays annually in pensions to Civil and Spanish war veterans and their widows, for these must keep many a native out of the poorhouse, while a much lesser proportion of foreign-born are helped in that way.

ANITA NEWCOMB MCGEE

WOODS HOLE, MASSACHUSETTS

## INVESTIGATIONS OF MAGNETOSTRICTIVE PHENOMENA

IN compiling the data for the various tables to appear in the International Critical Tables under the heading of Magnetostriction it is desired that as complete a survey as possible be made of the literature. In the hope of uncovering all possible sources of materials bearing on the various phases of magnetostriction, this call is sent out asking any one who has reprints of articles covering any particular subdivision of the subject to please send reprints of their work to the undersigned and where reprints are not available will those who have made contributions to this field please send references to the same address?

S. R. WILLIAMS,

*Cooperating Expert for Magnetostriction*

AMHERST COLLEGE,
AMHERST, MASS.

## QUOTATIONS

### POPULAR SCIENCE EXHIBITIONS

Now that the British Empire Exhibition has come to an end—for this year at any rate—it may be of interest to record some impressions of the manner in which the Royal Society's Exhibition of Pure Science, which was arranged in the government building, has appealed to the public, and of the extent to which it has fulfilled the objects with which it was organized.

The arrangement of this exhibition was undertaken by the Royal Society, at the request of the government, for the purpose of showing the essential part played by pure science among the multifarious interests and activities of the empire. Everywhere in the great exhibition the applications of science to industry were to be seen, but the fundamental work of scientific inquiry, in which many of them had their origin, would have been unrepresented unless some special effort had been made to bring it to the public notice. Accordingly, this exhibition, illustrating many aspects of purely scientific research at the present time, and indicating how industry has developed from similar inquiries in the past, was arranged.

The exhibition has not been without its humors. One was the difficulty of returning a satisfactory answer to the inquirer who, after spending some time in the galleries, said, "Yes, but how do you know there is an atom, and how do you know there are electrons inside it?"; and another, the problem presented by a visitor who, on observing that the Milne-Shaw seismograph has a rotating drum giving a record which has to be changed every twenty-four hours, asked, "What happens if there is an earthquake while you are changing the record?"

Nevertheless, it may be said that the exhibition has been an unqualified success. The public, non-scientific as well as scientific, has been really interested, and some, at least, must have gone away with a clearer understanding of the purposes for which men devote their lives to scientific experiment and inquiry. This success may be attributed largely to the policy adopted of making the exhibition a living one. The exhibits were contributed by scientific workers actually engaged in the researches represented, and supplemented where necessary to illustrate a subject fully, by instruments contributed by some of the leading makers. Wherever possible, actual demonstrations were given, and a scientific staff was in attendance throughout to carry out the demonstrations and to explain the exhibits. This policy was fully justified by the continued interest of visitors.

The handbook published in connection with the exhibition has been of great assistance. In this book is made available, for the small cost of a shilling, a series of non-technical articles on current scientific topics by leading authorities; and the best proof of its popularity is the fact that more than two thousand copies were disposed of, while its sale is increasing as it becomes better known, and is likely yet to continue now that the exhibition is closed.

The encouraging success which has met this attempt to present pure science in a less austere light than often surrounds it in the eyes of the general public, leads naturally to the inquiry as to whether a greater use can not be made of scientific exhibitions as a means to this end. Nothing but good can result from such efforts to spread a clear understanding of the true aims and purposes of science. That pure science is the modern expression of the elementary desire for knowledge—for the discovery of natural truths—that it is only by the disciplined quest in unknown fields that those benefits which science gives to the human race can accrue, is too little understood and too easily lost sight of, because of the very magnitude of the results themselves.

It ought to be possible to make an exhibition of this kind an annual event. The Scientific Products Exhibitions, organized by the British Science Guild in

1918 and 1919; the Scientific Novelties Exhibitions held at King's College, London, in connection with the King Edward's Hospital Fund in January 1923 and 1924, and experience at Wembley show that such displays of scientific work and results are much appreciated by the public. The desire for truth is at least as strong and as laudable an inspiration to the human spirit as the desire for beauty, and an event of this kind might well become to the world of science what the annual exhibition of the Royal Academy is to the world of art.

Such an annual exhibition would serve to maintain interest in the work of scientific inquiry, and help to keep it in the public mind in its just relation to the other activities in life. To men of science it might become a valuable auxiliary to the usual methods of publication of new scientific work, by reaching a wider public than the transactions of the scientific societies or the scientific periodicals can ever hope to do; and to the museums, it could be a source from which to obtain objects of interest from time to time, and thereby do much to prevent such national misfortunes as, for example, the dispersal, during the war, of the apparatus used by H. G. J. Moseley in his historic work on the X-ray spectra of the elements. It is to be hoped, therefore, that whatever facilities or funds are required to secure the continuance of the pure science exhibits and demonstrations now at Wembley will be provided.—*Nature.*

## SPECIAL ARTICLES

### PERIODIC REVERSAL OF HEART-BEAT IN A CHRYSALIS[1]

WHILE recently[2] studying two freshly formed chrysalids of *Colias eurytheme,* the cuticula of which was still transparent, I noticed that the heart was beating forward in one, as in insects generally, while in the other the direction of the beat was backward. This extraordinary phenomenon led me to watch the heart action of many pupae individually under a binocular dissecting microscope.

The profound internal changes in form of the mature caterpillar when it stops feeding and hangs itself up to shed its skin and become a chrysalis are accompanied by a periodic reversal in the direction of the peristalsis of the dorsal vessel. Beneath the larval skin the mature caterpillar is now wasp-waisted like the butterfly, and its wing buds are well formed. Its heart action then becomes essentially like that of the pupa, which, briefly, is as follows:

A period of rapid pulsation forward at the rate of approximately one wave of peristalsis per second is followed by a pause of 2 to 3 seconds. Then a slower pulsation at the rate of about one beat in two seconds and lasting for about 12 beats (25 seconds) occurs in *both directions,* forward from the third and backward from the fourth abdominal segments. Then the forward wave through the thorax usually stops altogether, and the whole dorsal vessel slowly pulsates backward at the same rate (about 0.5–0.6 beat per second). Toward the end of each phase just preceding reversal, the rate slackens slightly, but in the reversal to run *forward* there is little hesitation. The quick pumping forward is resumed without the noticeable pause that occurs at the end of the forward movement.

The number of beats forward and backward is subject to much variation, but in general the proportion of backward beats to forward increases with age.[3] Thus two larvae ready to pupate gave averages of 29.5 per cent. and 29.2 per cent. beats backward while two pupae, one fresh and one older, gave 41.3 per cent. and 59.2 per cent. backward. They beat as follows:

| Mature larva | Beats backward | Beats forward | Percentage backward | Temperature. |
|---|---|---|---|---|
| " " | 71 | 169 | 29.5 | 21° C. |
| " " | 47 | 114 | 29.2 | 21° C. |
| Fresh pupa | 78 | 111 | 41.3 | 25° C. |
| Older pupa | 180 | 124 | 59.2 | 21° C. |

It should be noted that in the two pupae just mentioned the first 10 to 15 strokes of the "backward" movements were mixed, including a forward pulsation through the thorax.

Another older chrysalis gave 238 beats backward to 196 forward (54.8 per cent. backward), the proportion of backward beats to forward showing no further increase but rather diminishing slightly as the number of beats in each phase lengthened; the backward beats in this pupa slackened to 0.33 beat per second, whereas the forward movement maintained a high rate (1.05 beat per second, temp. 24° C.)

The flow in the caterpillar up to the time when it stops feeding and prepares to pupate is always forward. This was true of every individual observed, but whether moulting affects the direction of circulation in the younger larval stages has not yet been determined. Since the hæmolymph is strongly colored, the outline of the dorsal vessel is clearly visible without a lens, as a dark green median-dorsal band against a paler green background. Closer examination shows that the dorsal vessel lies close to the

1 Research promoted by a grant from the Joseph Henry Fund.

2 October 21, 1924.

3 Exact counts with a stop-watch have been made upon eleven individuals. Thanks are due to Arthur M. Crosman, Joseph H. Berwick, K. W. Weeks, A. H. Lowell and L. J. Obermeier, who have served as timekeepers.

fairly transparent body wall and occupies a furrow traced through the whitish masses of dorsal musculature. The lateral outlines of the pericardium also can easily be distinguished. Mature larvae before the onset of pupation have regularly shown a *complete* reversal, that is, I have been unable to detect at the beginning of the backward phase any forward peristalis in front of the third abdominal segment.

Violent changes in circulation occur at the moment of pupation when the last larval skin is being stripped backward off the body. Relatively long periods then occur when the blood flows rapidly *in both directions,* backward and forward from the third and fourth abdominal somites where it appears to well up from a ventral sinus and to collect as in a transitory ventricle, alternating with much shorter periods of forward movement. While a strong aortic peristalsis directed forward is occurring in the thorax, an extremely strong flow backward occurs in the abdomen, where the dorsal vessel is now much dilated. Periods of flow in both directions lasted, in the caterpillar observed in the act of pupation, at first for about five minutes, alternating with periods of forward motion which were very short (25 seconds); then the forward phase became longer (68–70 seconds). The rate for all movements at first was about one beat per second, becoming only slightly more rapid in the forward phase (1.09 beat per second). During the first hour after shedding the larval skin the period of beating in both directions fell from 5 down to 3 minutes and the rate to 0.77 beat per second (139 beats in 180 seconds). The phase of forward motion, on the contrary, by one count had increased in extent to 111 seconds (113 beats), without further increase in the rate.

After the first day or two of pupal life the cuticula becomes so thick and opaque that it is usually impossible any longer to follow clearly the beating of the heart, but, in a chrysalis of *C. eriphyle* 60 hours after pupation, I observed 123 beats *forward* in 225 seconds (rate, 0.54 beat per sec.), then a very long pause of several minutes without detectable peristalsis, followed by a *backward* phase of 26 beats in 110 seconds (rate, 0.23 beat per sec.). Another backward phase included only 9 beats in 36 seconds (rate, 0.25 beat per sec.). Thus at 60 hours the forward and backward rates have each decreased by one half, though retaining with each other the same relation, and two successive phases are regularly separated by a long period of inactivity. I have not yet been able to determine whether periodic reversal of direction still occurs in the butterfly.

### AN EXPLANATION OF PERIODIC REVERSAL

To reach from behind the dome-shaped mesothoracic receptacle for blood at the base of the wings, the aorta is sharply bent ventrad and then like a siphon rises into the huge dorsal sinus, which is cut off from behind by high vertical walls. Into this relatively large hæmolymphatic reservoir for the wings, the fluid is pumped at the rate of one beat per second, till it is full to overflowing. The blood pressure in the wings is now probably at its greatest. Then something happens to relieve the pressure. Up to the time of pupation, immediate reversal of the peristalsis occurs in the thoracic aorta. Then the intense muscular activity of the pupa in relieving itself of the larval skin opens wide the longitudinal ventral sinuses between the thoracic-abdominal muscles; the blood rushes backward into the base of the abdomen where it wells up like a fountain into the pericardial sinus, thence into the heart, and we have, usually for 25 seconds, blood directed forward in the aorta and backward in the abdominal part of the dorsal vessel. Soon the aorta likewise reverses, and the whole dorsal vessel slowly siphons off, so to speak, the accumulated blood distending the bag-like wings. The pressure then being relieved, rapid forward peristalsis (of one beat per second) is once more resumed until the pause comes before the backward phase.

This pause may be interpreted as a period of maximum blood pressure in head and wings. The last forward strokes preceding it were somewhat languid, warning the observer that the pause was coming, that is, pressure was reaching its limit.

The hæmolymph in flowing backward to relieve the pressure meets obstructions. The contracted base of the abdomen, filled with cords of longitudinal muscle crowding upon the sinuses, and probably the smallness of the open ends of the arteries, make backaction difficult and slow. The "aortal chamber," described by Burgess[4] in the adult of *Colias philodice* and recently found by me there and in the chrysalis of *C. eurytheme,* undoubtedly helps largely in sucking in and driving backward the haemolymph.

I have observed in a pupa with aborted wing buds (affected either by disease or a noxious hereditary factor) that the backward phase was almost entirely omitted, being exceedingly short as compared with the forward phase. This shortness of the forward phase I interpret to mean that owing to the small capacity of the wings there is less blood to be pumped backward, so that the pressure is soon relieved and the free movement forward is quickly restored.

Periodic reversal to beat backward, in brief, means better irrigation of the wings, which in the pupa I regard as organs of excretion of uric acid products

[4] Burgess, E., 1881, "Note on the aorta of lepidopterous insects," *Proc.* Boston Soc. Nat. Hist. 21: pp. 153–156.

and probably of carbon dioxide. Reasons for this view will be set forth in detail in a later paper. Moreover, periodic reversal to beat backward means directing the main stream of hæmolymph toward the reproductive organs. This would seem to be a condition most favorable for the growth of the ovaries, which later in the female so fully fill the abdominal cavity.

"One swallow does not make a summer," and pupal circulation in this genus of butterflies may or may not be typical of that in all the different forms of higher insects with complete metamorphoses which make up such a large part of the animal kingdom. Few of them have colored blood, an unfortunate circumstance which is probably responsible for the fact that so little is known of periodic reversal of heart-beat. It has been described in the pupa of the silk-worm, however, by Bataillon.[5]

Periodic reversal in the direction of the heart-beat occurs, therefore, not only in Ascidians but is also an important characteristic of the metamorphosis of some and possibly most butterflies and moths. Wingless female moths are likely to prove an exception.

In the genus *Colias* periodic reversal of circulation is a most important feature in metamorphosis, as it may prove to be in other holometabolous insects.

John H. Gerould

Dartmouth College

## THE AGE OF THE PAYETTE FORMATION AND THE OLD EROSION SURFACE IN IDAHO[1]

The Payette formation, of continental origin, underlies extensive areas in the Snake River Valley south and west of Boise and in neighboring parts of southwestern Idaho and southeastern Oregon. The age of these strata is a matter of interest because they are the principal key to the Tertiary history of this region, and because beds correlated with them have been used in recent years by Umpleby, Lindgren, Blackwelder, Mansfield and others in attempts to establish the age of the widely recognized old erosion surface of central Idaho.

Lindgren,[2] in 1900, divided the Tertiary sediments of the lower Snake River Valley into two formations. The younger, comprising nearly horizontal strata, he termed the Idaho formation, after Cope, and assigned it to the Pliocene. Merriam[3] has since studied and determined a mammalian fauna from the Idaho beds as representing a late stage of that epoch.

The name Payette was applied by Lindgren[4] to the older more deformed strata underlying the Idaho. The formation was originally considered to be upper Miocene in age on the basis of its flora, studied by Knowlton, but in 1900 Lindgren assigned the Payette to the Eocene because of a revision of the flora by Knowlton. In later years, in discussions of the age of the Idaho Erosion Surface, Umpleby has considered the Payette as Miocene and Lindgren has referred to it as "Miocene (or Eocene)." Chaney,[5] in 1918, on the basis of additional plant remains, said ". . . at this time the writer is satisfied to make the reference to the Miocene without further specification." It thus appears that difference of opinion has existed regarding the age of the Payette.

In the course of field studies in the Snake River region the writer secured remains of two mammalian faunas from the Payette. One occurs in the lower part of the formation, in beds beneath the interbedded rhyolite, about one mile north of Rockville, shown on the Silver City Quadrangle of the U. S. Geological Survey. The second was found in the same section in strata overlying the rhyolite, probably disconformably, near Sands, about 11 miles northeast of Rockville. The beds at both localities dip to the north beneath the nearly horizontal Idaho formation, from which they are easily discriminated by their attitude and lithology.

The Rockville or lower fauna includes a proboscidean of the *Tetrabelodon* type, a species of *Hypohippus* resembling other forms in that genus from middle and upper Miocene formations of the Great Basin province, *Merycodus* sp., a large camel, a rhinoceros, fish bones and freshwater shells. Proboscidean remains first occur in North America in the middle Miocene; they are not abundant until upper Miocene time. This fauna may represent the middle Miocene, but it is more probably of upper Miocene age, and possibly even lower Pliocene.

The small fauna from Sands consists mainly of fragmentary *Hipparion* teeth and rodent teeth. The former resemble most closely in their complicated enamel patterns *H. anthonyi* from eastern Oregon and the hipparions from the lower Pliocene Ricardo formation of the Mojave Desert described by Merriam. The age of the fauna is approximately lower Pliocene.

[5] Bataillon, E., 1893, "La métamorphose du ver à soie et le déterminisme évolutif," Bull. Sci. France et Belgique. Tome 25. (Quoted from Henneguy, L. F., 1904. Les Insectes, p. 533).

[1] Published with the permission of the director of the U. S. Geological Survey and the secretary of the Idaho Bureau of Mines and Geology.

[2] Twentieth Ann. Rept., U. S. Geol. Surv., Pt. 3, pp. 93–99, 1900.

[3] *Bull. Geol. Soc. Amer.*, Vol. 29, p. 162, 1918.

[4] Eighteenth Ann. Rept., U. S. Geol. Surv., Pt. 3, pp. 632–634, 1898.

[5] *Am. Jour. Sci.*, Vol. IV, p. 220.

The age of the Payette is, therefore, middle Neocene. This accords with the stratigraphic evidence. The Payette overlies, probably comformably, the Columbia River lavas, which in other localities have been determined to be approximately middle Miocene in age.

Umpleby[6] originally advanced two reasons for considering the old erosion surface of central Idaho as old as Eocene. It was predicated that the sediments of Eocene age in the surrounding region had been derived from the peneplaned area during its reduction. The Payette was not included among these Eocene formations, perhaps because of its uncertain age and because it was believed to occupy valleys cut into the peneplane. But the Payette lies in post-Payette fault valleys and in diastrophic depressions of Payette and post-Payette date, and not in pre-Payette erosion valleys, in the uplifted region of southwestern Idaho. If we apply Umpleby's reasoning, based on derivation, this important body of sediments lying in an area adjacent to the peneplane would date the old surface as middle Neocene.

A second reason for considering the peneplane Eocene was that strata of supposed Miocene age occupied valleys cut during the Oligocene in the old surface in east-central Idaho. If again we use Umpleby's correlation and reasoning but recognize the upper Miocene age of the lower Payette and hence allow lower and middle Miocene time for the erosion of the valleys instead of the Oligocene, the erosion surface would be Oligocene in age instead of Eocene. If the valleys required less than lower and middle Miocene time for their excavation the erosion surface might even have been finished in lower Miocene time.

It appears therefore that, if we follow Umpleby's reasoning, the old surface is younger than Eocene.

JOHN P. BUWALDA
UNIVERSITY OF CALIFORNIA

[6] "An old erosion surface in Idaho," *Jour. Geol.*, Vol. 20, p. 142, 1912.

## ORGANIZATION OF THE WEST VIRGINIA ACADEMY OF SCIENCE

A MEETING for the purpose of organizing an Academy of Science was held at Morgantown, W. Va., under the auspices of the West Virginia Scientific Society on Friday, November 28, 1924.

After an address of welcome by President F. B. Trotter, the organization was effected and the following officers elected:

*President,* Dr. Geo. R. Bancroft, professor of physiological chemistry, School of Medicine, West Virginia University.

*Vice-president,* B. R. Weimer, professor of biology, Bethany College.

*Secretary,* Dr. John A. Eiesland, professor of mathematics, West Virginia University.

*Treasurer,* A. S. White, professor of social sciences, Marshall College.

The following sectional chairmen were elected for the ensuing year:

Biological section, A. M. Reese.
Chemistry and Pharmacy, Earl C. H. Davis.
Engineering, C. R. Jones.
Geology, Mining, John L. Tilton.
Mathematics, Physics and Philosophy, John Eiesland.
Social Sciences, J. E. Winter.

Special features of the meeting were a lecture by the Honorable A. B. Brooks, chief game and fish protector of West Virginia, on "Lighting the lamp of conservation in West Virginia," and, in the evening, an illustrated lecture by Dr. Francis H. Herrick, of Western Reserve University, on "Bird and animal instinct and intelligence."

The following papers were presented:

### BIOLOGICAL SECTION

*Microscopic Crustacea collected in the Canal Zone:* G. S. DODDS.

*Breeding of corn for resistance to smut (Ustilago zeae):* R. J. GARBER.

*Pit of pit vipers:* A. M. REESE.

*Habits of brook lampreys:* W. S. BOURNE.

*Some aspects of the axial gradient theory of structural relationship in organisms:* B. R. WEIMER.

*Discharge and dissemination of fungus spores:* N. J. GIDDINGS.

*Some aspects of the rôle of temperature in development:* L. M. PEAIRS.

*Smoke injury to vegetation:* J. B. RHINE.

*The development of the tetral wall and coats of the pollen grain:* P. D. STRAUSBAUGH.

*The West Virginia University course in public health:* F. E. CHIDESTER.

*Migration in animals:* F. E. CHIDESTER.

*Leaf mold of tomato:* R. C. SPANGLER.

*The female gametophyte of the Trillium sessile:* R. C. SPANGLER.

*Fresh water mussels—(Naiades):* W. L. UTTERBACK.

### CHEMISTRY AND PHARMACY

*Synthesis with chloro-ethers:* FRIEND E. CLARK.

*Variation in mineral content in Morgantown City water:* W. W. HODGE.

*Molecular orientation on solids in gels:* EARL C. H. DAVIES.

### ENGINEERING

*Bridge-building in West Virginia:* R. P. DAVIS.

*The use of the strain gage in engineering investigations:* G. P. BOOMSLITER.

*Tests on suitability of rocks of West Virginia for road-building purposes:* R. B. DAYTON.

GEOLOGY, MINING

*The terraces along the Monongahela:* S. B. BROWN.

*The conglomerate rocks of West Virginia:* D. B. REGER.

*The principles of soil classification:* E. P. DEATRICK.

*Some of the problems in oil and gas geology:* E. R. SCHEFFEL.

*Mining machinery:* M. L. O'NEAL.

MATHEMATICS, PHYSICS AND PHILOSOPHY

*Graphical methods and lines of force:* R. C. COLWELL.

*Some studies of absorption of light by mixed solutions:* E. F. GEORGE.

*The map-coloring problem:* C. N. REYNOLDS.

*The configuration of pencils of cubics:* B. M. TURNER.

*On the class of a centro-symmetric space in the theory of relativity:* JOHN EIESLAND.

*Logic in mathematical science:* H. E. CUNNINGHAM.

*Some low temperature measurements of refractive indices:* F. A. MOLBY.

SOCIAL SCIENCES

*Teaching of history and social science:* J. F. BOUGHTER.

*A study of blondes and brunettes:* J. E. WINTER.

## THE NEW MEXICO ASSOCIATION FOR SCIENCE

THE New Mexico Association for Science in affiliation with the New Mexico Educational Association for Science met at the State University of New Mexico, Albuquerque, on November 6 and 7. The following program was presented:

PRESIDENTIAL ADDRESS

*The scientific classification of school children:* DAVID S. HILL, State University of New Mexico.

AGRICULTURE

*Some factors influencing the permeability of soils:* C. W. BOTKIN, New Mexico College of Agriculture and Mechanic Arts.

ARCHEOLOGY

*Symmetry in Pueblo pottery forms:* KENNETH M. CHAPMAN, associate in ethnology, School of American Research, Santa Fe.

*Introduction of weaving in New Mexico:* LANSING B. BLOOM, School of American Research, Sante Fe.

*Some forgotten settlements in New Mexico:* PAUL A. F. WALTER, School of American Research, Santa Fe.

CHEMISTRY

*Scientific adjustment to the use of inferior fuels:* J. D. CLARK, State University of New Mexico.

*Selected methods for the preparation of alkyl phenols:* J. H. GRIFFITH, New Mexico State Teachers College, Silver City.

*Utilization of oxide slag in plastic bronze manufacture:* PAUL P. MOZLEY, Albuquerque High School.

EDUCATION

*Faculty control of high school athletics:* EDWARD LIGHTON, Albuquerque Public Schools.

*The vital need of college courses in modern synthetic geometry:* T. G. RODGERS, dean of the New Mexico Normal University.

*The teaching of science in the high school:* JESSIE SPENCER, Albuquerque High School.

*Needed reforms in methods of teaching science:* W. H. BALL, New Mexico Normal University.

*Modern hygienic requirements in school furniture:* CHARLES E. MCCLURE, Albuquerque.

ENGINEERING

*Sun engines:* T. T. EYRE, State University of New Mexico.

*The super-power system for the electrification of the United States:* P. S. DONNELL, State University of New Mexico.

SCIENCE OF LANGUAGE

*The Ablaut systems of Dlo, Del, Dol and Sup, Svep, Svop:* L. B. MITCHELL, dean of the College of Arts and Sciences, State University of New Mexico.

MEDICAL SCIENCE

*Progress in tuberculin treatment:* L. S. PETERS, Albuquerque.

*Recent advances in preventive medicine and sanitation:* G. S. LUCKETT, director of the State Bureau of Public Health, Santa Fe.

METEOROLOGY

*Long range weather forecasting:* R. S. ROCKWOOD, State University of New Mexico.

MINERALOGY

*The genesis of the great low-grade copper deposits of the Southwest:* E. H. WELLS, president of the New Mexico School of Mines, Socorro.

PHILOSOPHY

*The relation between language and thought:* GEORGE S. HUBBELL, State University of New Mexico.

PHYSICS

*Distortion in vacuum tube amplifiers:* R. W. GODDARD, New Mexico State College of Agriculture and Mechanic Arts.

*Importance of the Clement and Desormes experiment:* R. V. PRITCHARD, New Mexico State College of Agriculture and Mechanic Arts.

PSYCHOLOGY

*The relation of intelligence and school progress:* BENJAMIN F. HAUGHT, State University of New Mexico.